Minutes
of the
'WORKSHOP ON SOIL CONDITIONS AT FAIR'

held July 19, 2010
10 am – 6 pm
at GSI, Seminar room C27

Participants: Invited experts:
L. Evans (Chair MAC, CERN)
J. Kay (Diamond Light Source)
Tim Watson (ITER)
Lluis Miralles (CELLS)
W. Romberg (QM Geotechnik)
K.Otto, H. Tibes, U. Hermann, (ion42)
D. Lenz, H. Jelicka (LAP)
Guests:
D. Kraemer (FAIR TD), G. Aberin-Wolters (FAIR S&B), B. Schoenfelder (GSI WTI), U. Mattig (HMWK), J.T. Gierlinsky (Cahir FAIR ISC), Z. Majka (FAIR Research Director),
K. Zeyen (DRESO), R. Schulz (DRESO) , M. Pietsch (PBXF),

Protocol: W. M. Jacoby (FAIR)

The discussions following the presentations are summarized

Lyn Evans, chairman of the workshop formulates the basic questions:

FAIR is planning on civil construction. In this context a scheme of pillars to minimize the differential settling of buildings with time was derived.

- Are there alternative technical solutions for stabilization of the buildings?
- By which means would it be possible to save costs without sacrificing the required stability?

1. Presentation by D. Kraemer: **The Fair Project**

DK gives an overview on the FAIR Project with focus on the issue of differential settlement of the buildings.

2. Presentations by K.Otto/H.Tibes: **FAIR Site & Buildings**

The architects summarize their task to plan for the Modularized Start Version. Modules 0 to 3 to be built first; it is foreseen that other Modules are to be added as later options.
KO reviews boundaries set up on the realization of FAIR buildings originated from the B-Plan; significant differences upon the buildings are set depending to their location – north or south of “Prinzenschneise”.

3. W. Romberg: **Investigation of Soil Conditions at FAIR**

W. Romberg reviews the variety of experimental data that was derived from the analysis of 69 boreholes, investigation on ground water table, and first calculations on the response of the soil to the load of the individual FAIR buildings and tunnels.

The shear strength of the various soil layers is high enough to carry the load, however, depending on the specific pressure generated by the buildings, settlement of up to 40 cm have to be envisaged. According to simulations, only with optimized pillars underneath buildings and landfill, the requested settlement of neighbouring buildings is achieved after 1 ½ - two years after construction. However, to improve the quality of simulations an additional experimental program is suggested to allow most reliable calculations:
- additional 7-8 boreholes at critical points
- test of the behaviour of pillars
- load test on the ground to measure the response
- detailed non-linear 3D FEM simulations.

DK confirms that with the beginning of the "Genehmigungsplanung" these tests are planned for a better understanding of the ground situation.

The E-module for the upper soil layers was measured to be around 40 MPa. There is low dependency of the E-Module in the different layers. In Layer 6 it was found to be 80 MPa.

There are no additional experiences available from the GSI site or from the EMMI-Building.

As settlement is not avoidable and as the critical aspects of differential settlement no other technical solutions than pillars are available.

4. M. Jehlicka: **Planned Measures**

M. Jehlicka presents the concepts to compensate for the settling of ground. Critical issue is that all measures totally rely on the calculations.

MJ explains that typically 2/3 of the vertical movement takes place in the first two years after placing the masses. The piling will be made so that an equilibrium of the settlements will be reached.

The building problems are due to the large variety of specific pressure to the soil ranging from buildings as the fixed targets like Super FRS or p-Bar targets. These are equipped with radiation shielding walls of up to 8 m (e.g. generation a specific load of 40 to/sqm) to "light" service buildings with 10 - 20% of this value.

It is stated without pillars even after two years of construction the settlement will still be in the order of 2 - 3 cm per year.

It is pointed out that the final results will be sensitive to the sequence and timing of casting concrete and timing of ramp landfill.
A more optimized distribution of pillars is achieved only (maybe also a reduction of pillars) when the calculations are most realistic.

5. Jim Kay: **Diamond Light Source**
6. Lluis Miralles: **ALBA site geotechnical characterization**
7. Tim Watson: **ITER civil engineering**

The three presentations show means/arrangements/measures (that were taken) to meet specified requirements and achievements from the presenters' recent projects. Comparison of calculations made for the presented projects and measured results seem to indicate that calculations tend to over-estimate the effects.

Discussion:

Experts are convinced piling is the only technique available to influence the settlement of buildings? The question is not if we want to have pillars or not, the question is: what is the optimized configuration that allows/allowing to meet the requirements?

A test load with a large mass (50 m*50 m, 10 m high, soil) is required to improve the reliability of calculations.

FAIR is a cost-intensive scientific infrastructure that has to work without sacrificing degradation in performance by taking unpredictable risks in order to “save” investment cost. The responsible for the project have to deliver a working solution. Most important is that there is obviously no alternative to the piles.

More detailed information on the ground should be attained following the suggested additional tests to provide most reliable predictions on the soil behaviour.

Most probably the buildings in the south will have a critical influence to the existing GSI buildings. Attention should be paid to this topic.

Conclusions:

There are no alternatives to meet specified settlement of neighbouring buildings to the concept of piling.
All experts agree that the clearly presented data and simulation results indicate the need for measures to counteract building settlement to avoid significant degradation of the facility later on, i.e. loss of measurement time due to frequent realignment.
Piling is the only concept that will reduce the settlement by a factor 3 to 5.
It is strongly recommended to improve the detailed knowledge of the soil conditions applying test piles, further boreholes, and a test mass in order to obtain improved input for additional and more reliable 3D-calculations.

W. Jacoby 20.07.2010